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The effects of pressurizing various functional units of an experimental pneumatic-lever anti-G suit (PLS; frequently called a capstan suit) on $+G_z$ tolerance and protection were determined at relaxed $+G_z$ levels and during $+6\ G_z$ for 60 s -- termed high sustained G (HSG). $+G_z$ tolerance and protection were measured on 9 male subjects using light loss criteria, increases in heart rate during HSG and subjective analysis. These data from the PLS were compared with similar findings obtained from the same persons wearing the USAF standard over

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anti-G suits (CSU/12P) with and without suit pressurization. Abdominal bladder inflation offered the highest increase in relaxed $+G_z$ tolerance (0.7 G) whereas leg pressurization offered the greatest anti-G protection (heart rate criterion and subjective analysis) at HSG. Specifically regarding the PLS, it was found superior to the CSU-12/P at HSG regarding both $+G_z$ protection and subject comfort.

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G-Tolerance and Protection with Anti-G Suit Concepts

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The effects of pressurizing various functional units of an experimental pneumatic-lever anti-G suit (PLS; frequently called a capstan suit) on $+G_z$ tolerance and protection were determined at relaxed $+G_z$ levels and during $+6\ G_z$ for 60 s—termed high sustained G (HSG). Measured were $+G_z$ tolerance and protection on nine male subjects using light loss criteria, increases in heart rate during HSG and subjective analysis. These data from the PLS were compared with similar findings obtained from the same persons wearing the USAF standard anti-G suits (CSU-12/P) with and without suit pressurization. Abdominal bladder inflation offered the highest increase in relaxed $+G_z$ tolerance (0.7 G) whereas leg pressurization offered the greatest anti-G protection (heart rate criterion and subjective analysis) at HSG. Specifically regarding the PLS, it was found superior to the CSU-12/P at HSG regarding both $+G_z$ protection and subject comfort.

PRESENTLY, the use of the anti-G suit as a method of increasing G-tolerance is being re-examined emphasizing its value as a personnel support garment at high sustained G (HSG) levels (3) ($+6\ G_z$ and above for durations of exposure longer than 15 s). Standard operational anti-G suits are comprised of two functional units—resulting in compression of the: (a) abdominal region and (b) major leg muscles—using pneumatic pressurization techniques. Little is known, however, about the specific anti-G value of each of these functional units; i.e., G-tolerance studies routinely use and evaluate the entire anti-G suit.

Accordingly, in order to evaluate in detail the use of the anti-G suit during exposures to HSG, it became necessary to determine specifically the anti-G value of each of the functional units of the suit. This was accomplished by determining relaxed and straining HSG tolerances of human volunteers wearing appropriately modified anti-G suits and exposed to various levels and durations of $+G_z$.

MATERIALS AND METHODS

Nine male volunteers were trained to tolerate HSG using the (6.1 m radius arm) centrifuge at the School of Aerospace Medicine, Brooks AFB, Tx. All subjects were physically qualified with a class II flying physical examination. The method used to expose subjects to $+G_z$, is described elsewhere (11).

Three types of anti-G suits were worn by these men to examine the value of basic anti-G suit concepts (Fig. 1): (a) single bladder anti-G suit (SBS, modified CSU-4/P); (b) pneumatic lever anti-G suit (PLS; modified capstan-type suit†; and (c) standard operational USAF

The research reported in this paper was conducted by personnel of the Environmental Sciences Division, AFSC, United States Air Force, Brooks AFB, Tx.

The voluntary informed consent of the subjects used in this research was obtained in accordance with AFR 80-33.

†The development of the pneumatic lever suit as an anti-G device was pioneered by Dr. Harold Lamport *et al.* at the John B. Pierce Foundation, New Haven, Ct. For this reason, the PLS is occasionally called the Lamport Suit—details regarding its development are available (7,8,9).

anti-G suit CSU-12/P (5 bladder/suit; 5BS). Both the PLS and SBS high altitude-type suits were modified into experimental anti-G suits; viz, the upper body functional portion of each suit was removed at waist level. In addition, the PLS was modified with an abdominal bladder—like the abdominal bladder of the 5BS. Since the pneumatic levers of the PLS extend pressure to the body at a 5:1 (lever:skin) ratio; and whereas the abdominal bladder operates on a bladder:skin pressure ratio of 1:1, it was necessary to inflate each unit of the PLS separately using two anti-G valves—note the two pressure inlet tubes extending from the PLS in Fig. 1. (Details regarding the principles, operation, and modifications of the PLS are available (2)). The two pressure inlets of the PLS uniquely allowed for separate pressurizations of the abdominal and leg regions.

Both the 5BS and PLS anti-G suits automatically began pressurization at 2.2 G. The 5BS and abdominal bladder of the PLS were inflated at the rate of 1.5 psi/G whereas the pneumatic levers were pressurized at 3 psi/G, which was the maximum pressurization rate possible with our valve. This is unfortunate since the 5:1 ratio pressure reduction resulting from the pneumatic lever concept translated the leg pressurization rate of the PLS to approximately 0.6 psi/G—less than one-half the rate of the 5BS. The SBS was pressurized manually to the appropriate psi during HSG onset. Suit pressures of 2, 3, and 4 psi (each psi setting per 60 s +6 G_z exposure) were used

Relaxed G tolerances‡ for a specific pressurization schedule were measured once a week using light loss criteria—100% peripheral light loss (PLL) with 50% central light loss (central light dim, CLD). G-tolerances were determined on the same day for both rapid onset rates (ROR; 1 G/s) and gradual onset rates (GOR; 0.1 G/s) for both the 5BS and PLS. The SBS was used only in a portion of the HSG phase of this study. This anti-G suit has been evaluated previously relative to relaxed G tolerance (6).

Exposure to HSG (+6 G_z for 1 min maximum exposure allowed) was accomplished with a particular anti-G suit pressurization also on the same day and after relaxed G tolerances were obtained. During exposure to HSG, the subject performed the M-1 straining maneuver, as necessary, to maintain adequate vision (11). Electrocardiograms (ECG; two leads) were continuously monitored for heart rhythm and rate. These data, G-suit pressures, and G levels were recorded (analog) using a Mark 200 Brush recorder.

RESULTS

Relaxed +G_z Tolerance

Relaxed ROR and GOR +G_z tolerance for nine adult males wearing either the 5BS or PLS (group means ± standard errors) are shown in Table I. The ROR tolerances (group mean) found for either anti-G suit without pressurization was the same, 4.0 G. This is similar to the 4.1 G relaxed tolerance level reported by Parkhurst et al. (11) in their HSG study where subjects wore the 5BS without pressurization. Both Parkhurst *et al.* (11) and Burton *et al.* (2) reported a 0.3 to 0.4G increase in ROR tolerance as a result of wearing either the 5BS or PLS anti-G suit without application of pressure. Therefore, in our study it is assumed that 0.3 of the 4.0 mean control-relaxed-tolerance result from the sub-

‡ Although the term indicates the use of a relaxed subject it is unusual for a person to truly relax during exposure to +G_z.

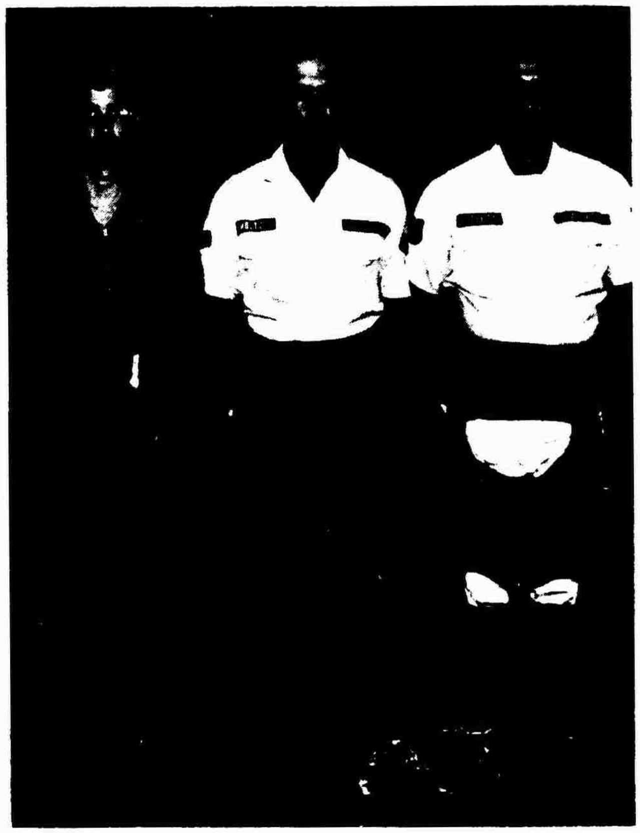

Fig. 1. The three anti-G suits used in this study are shown left to right: (a) single bladder suit (modified CSU-4/P); (b) pneumatic lever suit (modified capstan type low-pressure); and, (c) USAF standard CSU-12/P suit.

TABLE I. RELAXED ROR AND GOR +G_z TOLERANCE (MEAN ± S.E.) FOR NINE MALES WEARING EITHER THE CSU-12/P (5BS) OR PNEUMATIC LEVER (PLS) ANTI-G SUITS WITH AND WITHOUT SUIT PRESSURIZATION. THE ANTI-G EFFECT FROM INFLATING ONLY THE LEG OR ABDOMINAL PORTION OF THE PLS IS ALSO COMPARED.

	Control No Pressure (NP) (Both Suit Types)	5BS*	PLS*	Abdominal Pressure†	Leg Pressure†
ROR mean	4.0	5.0**	4.9**	4.7**	4.2
±S.E.	0.29	0.30	0.31	0.30	0.36
GOR mean	5.0	5.9**	5.6**	5.4**	5.2
±S.E	0.27	0.28	0.26	0.31	0.39

* Suits were pressurized (note text);
**Significantly different from NP control +G_z tolerance $p < 0.01$ using paired t-testing.
† PLS was used (note text).

ject wearing the snug fitting nonpressurized anti-G suit; i.e., mean $+G_z$ tolerance in (HSG-type) men without the anti-G suit would approximate 3.7 G.

The effect of pressurizing both suits and specific portions of the PLS upon the $+G_z$ tolerance is seen in Table I. Similar ROR tolerances were found for both the 5BS and PLS suggesting similar anti-G benefits (both qualitative as well as quantitative) for both suits. The net increase in $+G_z$ tolerance resulting from pressurization of the PLS was 0.9 G—0.7 G is a response to abdominal pressure and only 0.2 G results from leg pressurization. It appears, therefore, that the total anti-G benefits arising from the PLS are equal to a summation of the specific activities of each functional unit—0.7 G (abdominal pressure) +0.2 G (leg pressure) = 0.9 G total anti-G increase in ROR $+G_z$ tolerance.

The GOR relaxed $+G_z$ tolerance help resulting from anti-G suit inflation also appears to be a summation of leg and abdominal pressures. The $+G_z$ tolerances of those men wearing the PLS were significantly less (0.3 G; statistically significant with paired t testing $p<0.05$) than found for the same men wearing the 5BS. This difference probably results from the fact that greater (optimal) leg pressurizations of the PLS were not possible with our anti-G valve (note methods).

The summation effect of increases in $+G_z$ tolerance (Table I) which results specifically from either the GOR (1 G), or anti-G suit (0.9 G) when these are combined (1.9 G) has been reported previously (5).

The effects of various anti-G suit applications on ROR $+G_z$ tolerance on an individual basis were considered using regression analyses by comparing each subject's $+G_z$ tolerance (anti-G suit on but without pressure) with the tolerance found when his anti-G suit was inflated. The following basic equation was derived—the values for specific regressions are found in Table II:

$$P = a + bS \qquad \text{(Eq. 1)}$$

where P = $+G_z$ tolerance (ROR) of persons wearing an anti-G suit with appropriate pressurizations during G, and,

S = $+G_z$ tolerance (ROR) of the same persons wearing the same anti-G suit but without pressure during G.

Considering the four equations (Table II), pressurization of anti-G suits appears to increase the $+G_z$ tolerance of persons with low $+G_z$ tolerance to a greater extent than those with higher tolerance—note the slopes "b" are <1 and the intercepts "a" are greater than the actual increase in $+G_z$ found with suit inflation (Table I).

The coefficient of determination was calculated as the square of the correlation coefficient (r^2) for each equation. The coefficient of determination ($\times$ 100) in these instances indicates the percentage of the variation in $+G_z$ tolerance in persons wearing the pressurized anti-G suit that is due to their natural $+G_z$ tolerance without the aid of suit-pressure. The remaining variation (100-r^2%) is due to unexplained factors (usually experimental error); however, it is interesting to note that the coefficient of determination for the 5BS is approximately half that of the PLS, yet the experimental design (and presumably error) was the same for both suits.

A subjective analysis of the two anti-G suits was made by comparing the PLS with the 5BS. The subjects were first exposed to centrifugation using the 5BS, at which time they mentally noted the support and comfort of this suit. All later $+G_z$ exposures were made with the PLS (entire suit inflated; abdominal bladder only inflated; or leg portion only inflated) after which the men were asked to evaluate the suit relative to the previously used (completely inflated) 5BS. Their opinions regarding (a) support or (b) comfort were graded as follows: PLS less than 5BS = 1; PLS the same as 5BS = 2; or PLS better than 5BS = 3. A statistical summary of these data for both relaxed $+G_z$ and HSG exposures is shown in Table III. (The HSG portion will be considered later in this text).

Interesting, during relaxed $+G_z$, the feeling of comfort was not necessarily synonymous with the feeling of support although both support and comfort are possible with an anti-G suit inasmuch as the PLS received high marks (relative to the 5BS) for support and comfort when the entire anti-G suit was inflated. It is emphasized here that the PLS always received high grades for comfort from all subjects. The subjective quantification of suit-support during relaxed $+G_z$ exposure is not correlated with the increase in $+G_z$ tolerance afforded the men by inflating either the abdominal bladder or leg region—leg pressurization alone gave them the feeling of

TABLE II: ROR $+G_z$ TOLERANCE CORRELATIONS AND REGRESSION ANALYSES ARE COMPARED BETWEEN INDIVIDUALS (N = 9) WEARING AN ANTI-G SUIT NOT INFLATED AND WITH STANDARD SUIT PRESSURIZATION

ANTI-G SUIT (No Pressure)	Standard Pressure†	r*	P<#	b††	a††	r^2(%)§
5BS	A** + L**	0.68	0.05	0.87	1.6	46
PLS	A + L	0.93	0.01	0.80	1.7	86
PLS	A	0.89	0.01	0.74	1.7	79
PLS	L	0.94	0.01	0.93	0.44	88

† For pressurization schedule consult test;
*r = correlation coefficient;
# P < = probability of chance occurrence;
†† a and b = constants for the equation: P = a + b S (note text);
§r^2(%) = (correlation coefficient)^2 $\times$ 100 = coefficient of determination(%);
**A = abdominal pressurization and L = leg pressurization.

TABLE III: COMPARISON* OF PLS PRESSURIZATIONS WITH THE 5BS RELATIVE TO SUBJECT SUPPORT AND COMFORT DURING RELAXED $+G_z$ EXPOSURES AND TO HSG.

Anti-G Suit Pressurization	SUPPORT Relaxed	SUPPORT HSG	COMFORT Relaxed	COMFORT HSG
Abdominal Pressure (A)	1.7±.24†	1.9±.30	2.4±.24	2.6±.24
Leg Pressure (L)	2.1±.26	2.1±.26	2.6±.29	2.6±.29
A + L (A/L)	2.8±.12	2.8±.12	2.7±.15	2.7±.15

* Method of scoring is described in the text.
† mean ± standard error; number of subjects per group is nine.

TABLE IV. DURATION (s) OF EXPOSURE TO $+6G_z$ TOLERATED BY NINE SUBJECTS WEARING EITHER THE SBS OR PLS. (60 s WAS MAXIMUM G EXPOSURE ALLOWED.)

	SBS		PLS		
SUBJECT	NP#	P#	A/L#	A#	L#
1	60	60	60*	60	60
2	47	60	60	60	60
3	60	60	60	57	60
4	30**	60	60	60	60
5	60	60	60*	60	60*
6	60	60	60	10	60
7	60	60	60	60	60
8	42	18†	60	53	60
9	30**	52	41	32	60
$\overline{X}$	50	54	58	50	60
± S.E.	4.4	4.6	2.1	5.9	0

* M-1 was not necessary to tolerate $+G_z$;
** subject could have continued—run stopped by observer;
† leg pain (subject stopped run);
\# NP = suit not pressurized; P = standard pressurization; A/L, A, L = note Table III.

TABLE V. HEART RATE (GROUP MEAN ± S.E.) OF NINE MEN EXPOSED TO $+6G_z$ FOR 60 s MAXIMUM. THE SUBJECTS WORE THE SBS OR PLS WITH VARIOUS SUIT PRESSURIZATIONS.

Suit Pressurization		Heart Rate (mean ± S.E.)	p<*
SBS:	no pressure	165 ± 3.1	N.A.
	standard pressure	160 ± 3.8	0.16
PLS:	A/L†	150 ± 7.9	0.06
	A†	164 ± 2.5	0.77
	L†	154 ± 7.2	0.10

* statistical probability of chance occurrences using paired t-testing with SBS (no pressure); NA = not appropriate;
† note Table III regarding abbreviations.

TABLE VI. EFFECT OF VARIOUS ANTI-G SUIT PRESSURES ON HEART RATE AT +6 G_z, USING THE SBS COMPARED WITH NO PRESSURIZATION AND STANDARD INFLATION PRESSURES USING THE SBS.

		SBS (psi)			
Subject	0(SBS)	2	3	4	SBS*
1	170	137	134	134	140
2	162	170	162	147	160
3	152	158	150	135	156
8	162	137	133	127	160
9	165	159	152	146	168
$\overline{X}$	162	152	146	138**	157
S.E.	2.9	6.5	5.6	3.8	4.6

* standard inflation;
** significantly different ($p < 0.01$) from 0 PSI heart rates and SBS (standard inflation) using paired t-testing.

support whereas the principal increase in relaxed $+G_z$ tolerance was associated with abdominal pressurization.

High Sustained $+G_z$ Tolerance

Tolerance to HSG was determined using: (a) duration of exposure to +6 G_z without CLD (maximum of 1 min exposure allowed); (b) mean heart rate during HSG exposure; and, (c) subjective analysis.

Tolerance durations of exposure to HSG in nine subjects wearing the SBS (pressurized and not pressurized) or PLS (various portions or all of the suit pressurized) are shown in Table IV. Five of nine subjects were able to tolerate the maximum $+G_z$ stress without anti-G suit pressurization. In fact, suit pressurization had an unpredictable effect on tolerance to HSG and not necessarily correlated with suit benefits during relaxed $+G_z$ exposures; i.e., leg pressurization only of the PLS appeared to offer the greatest help during HSG.

Heart rate, as a criterion of heart stress, during HSG exposure was measured on the nine men and the group mean (± standard error) heart rate is compared for the two anti-G suits with various pressurizations in Table V. The greatest reduction in heart rate (compared with the heart rate at +6 G_z in the same persons wearing the SBS without pressurization) resulting from anti-G suit pressurization occurred in those men wearing the PLS with standard pressurization—although the mean reduction in heart rate was only 15% (150 compared with 165). The reduced heart rate associated with the PLS appears to be principally a function of leg pressurization —abdominal pressurization alone essentially has no effect on heart rate.

The effect of leg pressurization on heart rate at +6 G_z for 1 min was considered in more detail using the SBS. As noted earlier, we were restricted as to the amount of pressurization of the legs that was possible using the PLS—at +6 G_z leg-skin pressure approximated 2 psi. Using the SBS, we were able to increase the leg-skin pressurization above 2 psi (3 and 4 psi) and thereby determine the effect of leg pressure upon heart rate—total leg area pressurization (excluding the feet) is possible with both the SBS and PLS.

Five of the original nine subjects used the SBS at +6 G_z for 60 s at 3 suit pressures (one HSG exposure with one pressure per week). Suit pressurizations of 2, 3, and 4 psi were considered—their heart rate data at these pressurizations are compared, on an individual basis (Table VI), with heart rates obtained while they were wearing the SBS (with and without pressurization).

The group mean heart rate of 152 using 2 psi and the SBS is similar to the mean heart rate of the nine subjects while wearing the PLS with the legs pressurized (Table V)—the effect of the leg pressurization upon heart rate is similar for both SBS and PLS suits which is to be expected considering the similarity between the two suits in leg coverage.

Increased pressurization of the leg region reduces heart rate at HSG below those levels found in persons tolerating +6 G_z without suit pressurization, although the reduction in heart rate is not statistically significant (paired t-testing) until 4 psi is reached.

The effect of leg pressurization on heart rate during exposure to 1 min of +6 G_z appears to have an inverse rectilinear relationship:

$$H = 163 - 6L \qquad \text{(Eq.2)}$$

where H = heart rate (per min)

L = leg pressurization (psi)
$r = 0.66; p<0.01$

Each psi of leg pressurization (0 to 4 psi) reduces the mean heart rate by six beats per minute while the subject is at $+6\ G_z$.

Subjective analysis of anti-G suit performance was determined for HSG as it was for relaxed lower G levels (Table III). Support and comfort analysis for HSG was both qualitatively and quantitatively similar to that reported for the relaxed tolerances—greater support and comfort with the inflated PLS; viz leg pressurization subjectively appears to be a most important consideration regarding suit support at $+G_z$, although, the addition of abdominal pressure with leg pressurization increased the subjective desirability of the PLS.

In a recent experiment, Leverett et al. (10) reported that at $+6\ G_z$ (60-s exposures), five of six subjects experienced severe lower leg pain (calf region) while wearing an inflatable RAF mini-anti-G suit. This British prototype suit is similar to the 5BS of this study except the lowest leg (calf) bladders had been removed. We were interested to determine if removal of all leg support would alter this painful condition at HSG. Considering nine subjects (5 HSG exposures each for a total of 45 HSG exposures), only seven instances of leg pain occurred—involving either the thigh or calf region—and none of these occurrences of leg pain was as severe as reported previously (10). The incidence of pain (subject complaint) associated with specific anti-G suits and pressurizations follows: 5BS (no pressure) = 1; 5BS (standard pressure) = 3; PLS (abdominal pressure only) = 2; PLS (leg pressure only) = 1; and, PLS (fully pressurized) = 0. Apparently, suit application (without pressurization) to the calf region prevents the pain or pressurization only of the thigh region as it occurs in the mini-suit is necessary to produce the pain.

DISCUSSION

The principal difference between the PLS and 5BS is that the former has a more complete and uniform coverage of the subject's legs, which should result in a more effective method of reducing lower-body blood pooling and increasing vascular resistance—both of which should increase both relaxed and HSG tolerances.

Wood and Lambert (12) examined the effect upon relaxed $+G_z$ tolerance of inflating either the legs or abdominal portion of a 5BS. They reported an increase in relaxed $+G_z$ tolerance of 1.2 G with total suit standard inflation—abdominal pressure inflation, acting alone, accounted for 0.6 G and leg pressure alone provided 0.2 G. They concluded that when leg and abdominal pressurizations were concurrent the anti-G responses of the specific units of the suit became synergistic.

In our study, we also found only a 0.2 G increase in relaxed tolerance when the legs only were pressurized and a 0.7 G increase associated with abdominal bladder inflation. However, when both suit parts were inflated concurrently, we had only a summation effect on the increase in $+G_z$ tolerance. It appears that Wood and Lambert (12) may not have considered the increase in $+G_z$ tolerance which results from simply donning the anti-G suit; i.e., their control subjects apparently did not wear an anti-G suit. Summarizing our results at relaxed G tolerances with the PLS, it appears that an anti-G suit offers 1.2 G increase in relaxed tolerance as follows: 0.3 G from the suit without pressure; 0.2 G from pressurizing the legs; and 0.7 G by inflating the abdominal bladder. In this regard, it is important to remember that the leg-skin pressurization used in our experiment was less than half the pressure usually found in experiments using the 5BS; viz, it appears that uniform pressure distribution and coverage of the legs results in a more effective anti-G effect on relaxed subjects.

Recently, interest in anti-G concepts has considered tolerance and protection at HSG, with less emphasis on relaxed $+G_z$ tolerance. It is appropriate that anti-G concepts, which are to be used during HSG, should be tested and examined at high G levels, since it appears that the physiologic responses to HSG are more than an extension of the physiological alterations associated with lower G levels for short duration (3). However, methods used to quantify tolerance to HSG have not been developed and standardized as have systems for determining relaxed $+G_z$ tolerances. Since exposure to HSG can inflict heart pathology on experimental animals, e.g., the mature miniature swine (4), it is not reasonable that human tolerance to HSG be quantified by the highest sustained $+G_z$ level man can endure without losing vision or consciousness. Consequently, more sophisticated methods are presently being considered at the School of Aerospace Medicine as determinants of tolerance to HSG where the concept of protection of the man is an integral consideration in quantifying HSG tolerance. Burton and Krutz (1) quantified physiologic protection afforded at HSG as "the ability of an anti-G effort to prevent or at least reduce physiologic changes during G." Three parameters were examined: (a) heart rate, (b) esophageal pressure, and (c) arterial oxygen tension. All three were found acceptable for use during HSG with heart rate being quite sensitive and, of course, the least difficult to obtain.

Accordingly, heart rate was used in our experiment as a determinant of HSG protection ("tolerance") associated with various anti-G suit inflation concepts. In our study we found leg inflation to be of little value (0.2 G) to relaxed $+G_z$ tolerance (abdominal inflation was predominate) whereas during HSG the lowest increase in heart rate (greatest HSG protection) accompanied leg pressurization (Tables V and VI). Certainly, the value (subjective evaluation) of proper leg pressurization at HSG was demonstrated in the study of Leverett *et al.* (10) where the RAF mini-anti-G suit was evaluated and severe lower leg pain developed in the majority of subjects. On the other hand, abdominal bladder inflation alone (without leg pressurization) essentially had no protective value at HSG (considering heart rate, Table V) and considering tolerance as a function of duration of time at G, abdominal pressurization was less effective than the 5BS without pressure.

Subjective analysis of anti-G suit performance, in this

experiment, was found to be quite accurate at HSG, yet did not correlate with more objective parameters at relaxed G tolerances (Table III). This is not surprising, since the value of the anti-G suit during HSG is its ability to improve tolerance by reducing physiologic alterations associated with G and the M-1 straining maneuver—something that a subject could well perceive, whereas a slight increase in a blackout tolerance associated with relaxed G exposures would be difficult for a person to subjectively identify and quantitate.

The PLS used in this study appears to provide anti-G relaxed tolerances similar to those found in the more conventional 5BS with less leg-skin pressurization and greater personal comfort. At HSG, the PLS was superior to the 5BS in protecting subjects and this accomplished also with greater comfort. Presently, newly designed anti-G suits of the PLS type are being considered for more extensive evaluations in the near future.

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